PUTTING RESEARCH TO WORK

BRIEF

Evaluating the Performance of Whitetopping Overlays in Wisconsin

As asphalt pavements age, they are subject to rutting, cracking and other deterioration. To rehabilitate roads that are not so badly damaged that they require reconstruction, WisDOT uses low-cost maintenance techniques such as overlaying an existing pavement with hot mix asphalt.

However, the rutting and cracking of original pavements can spread upward into HMA overlays, which are sensitive to an underlying layer's condition. Consequently, engineers developed whitetopping, a rehabilitation method that involves placing a layer of portland cement concrete over an asphalt pavement.

In conventional whitetopping, this layer is placed in rectangular slabs of 4 inches or more in thickness. Slab dimensions are usually less than those typically used in a new-construction concrete pavement and so are more resistant to stresses. Variations called "thin whitetopping" and "ultra-thin whitetopping" use layers that are less than 4 inches thick and also involve bonding the PCC layer to the underlying layer by texturing the asphalt. Most ultra-thin whitetopping overlays also use fiber-reinforced concrete, which contains steel, glass or synthetic fibers to increase their structural integrity, making the concrete slabs less likely to crack.

What's the Problem?

Whitetopping is still a relatively new rehabilitation technique and its performance nationwide has been mixed. Further, while a number of whitetopping projects had been constructed in Wisconsin, there had been no follow-up research analyzing their performance in a rigorous way. Research was needed to understand how whitetopping performance varies with design and to estimate the average service life for whitetopping so that it can be incorporated into pavement life-cycle cost analyses.

Research Objectives

The primary objectives of this study were to relate the design elements and construction procedures of unbonded whitetopping and bonded ultra-thin whitetopping projects in Wisconsin to their performance to improve their design and estimate their service lives.

Methodology

Researchers assessed the field performance of six whitetopping and 11 ultra-thin whitetopping projects constructed in Wisconsin from 1995 to 2007. PCC layer thicknesses ranged from 4 inches to 9 inches, and slab dimensions ranged from 4 by 4 feet to 15 by 15 feet. Thirteen projects used fiber-reinforced concrete.

Researchers began by taking field cores—cylindrical samples cut out of the pavement—from each project and testing them in the laboratory for shear strength, or resistance to parallel sliding between the HMA and PCC layers. Then they used a falling weight deflectometer to take field measurements of resilient modulus, a value that can be used to backcalculate stiffness-related properties of pavements. The FWD simulates the load of a vehicle wheel by dropping a heavy, circular plate and measuring the resulting deformation of the pavement. A backcalculation method is then used to iteratively adjust assumed moduli until they converge on measured surface deflections.

Researchers then conducted visual field distress surveys on in-service projects to assess slab cracking as well as faulting and spalling at the joints between slabs. To test the concrete material fatigue limit, they also applied various axle loads to the edges and corners of slabs, and calculated the maximum number of load applications the pavement could withstand before failure. Finally, researchers created a database of results for these projects, compared their performance to that of whitetopping projects in other states and statistically analyzed design factors affecting performance.

Investigator

"These findings are important for DOTs nationwide that wish to evaluate the performance of whitetopping, which with some design improvements could be a promising pavement rehabilitation method."

–Haifang Wen
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To evaluate shear strength, researchers used the Iowa DOT method in which a continuous load is applied at a right angle to a specimen at the seam where the overlay concrete meets the underlying asphalt. This load is applied until the surfaces shear away from each other.

Project Manager

"This is the first time that the performance of Wisconsin whitetopping pavements has been evaluated, and results may lead to adjustments to WisDOT procedures for concrete overlays."

–Jim Parry
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Results

The study found that the performance of whitetopping projects in Wisconsin was comparable to that in other states, and that whitetopping shows great promise as a rehabilitation technique if its design methodology is improved. The most important factors affecting the performance of these projects were overlay thickness, joint spacing and pavement age. Other factors included underlying HMA conditions, pre-overlay treatment methods and concrete materials.

Researchers recommended the development of a design method to reduce the variation in performance of whitetopping pavements in Wisconsin. Because core results indicated that the bond between concrete and asphalt is frequently lost, designs should assume an unbonded condition. Because whitetopping overlays are very sensitive to axle loads higher than the standard 18,000 pounds per axle, designs should be based on heavier loads.

FWD results showed that traditional backcalculation methods for concrete pavement layer properties are not applicable to ultra-thin whitetopping pavements. Researchers developed a new procedure, the Critical Distance Method, which correlated PCC modulus and pavement performance reasonably well.

Implementation and Benefits

With further research, these results may lead to adjustments to WisDOT's concrete overlay procedures and manuals. In general, they will help highway agencies make informed decisions regarding appropriate rehabilitation techniques by accurately assessing performance and estimating service life.

Further Research

Researchers recommend more study to confirm these findings. Other research needs include the calibration of the Mechanistic-Empirical Pavement Design Guide based on the performance of whitetopping pavements nationwide, and its refinement based on the performance of pavements in Wisconsin. Finally, FWD backcalculation methods for whitetopping pavements should be further developed and validated.

This brief summarizes Project 0092-08-10, "Performance Assessment of Wisconsin's Whitetopping and Ultra-Thin Whitetopping Projects," produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, PO Box 7915, Madison, WI 53707.

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